SELF-AUTHENTICATING DOCUMENTS

RELATED INVENTIONS

This application is related to S.N. 09/005,736, filed 01/12/98, which is a continuation-in-part of S.N. 08/564,664, filed 11/29/95, now U.S. Patent 5,708,717, Jan. 13, 1988, the contents of which are herein incorporated by reference.

FIELD OF THE INVENTION

This invention relates to security documents and in particularly to a self-authenticating document system including the use of a synthetic paper material containing integral authentication and verification means.

BACKGROUND INFORMATION

To prevent unauthorized duplication or alteration of documents, frequently there is special indicia or a background pattern that may be provided for sheet materials such as tickets, checks, currency, and the like. The indicia or background pattern is imposed upon the sheet material usually by some type of printing process such as offset printing, lithography, letterpress or other like mechanical systems, by a variety of photographic methods, by xeroprinting, and a host of other methods. The pattern or indicia may be produced with ordinary inks, from special inks which may be magnetic, fluorescent, or the like, from powders which may be baked on,

1   from light sensitive materials such as silver salts or azo

2   dyes, and the like. Most of these patterns placed on sheet

3   materials depend upon complexity and resolution to avoid ready

4   duplication. Consequently, they add an increment of cost to

5   the sheet material without being fully effective in many

6   instances in providing the desired protection from unauthorized

7   duplication or alteration.

8   Various methods of counterfeit-deterrent strategies have

9   been suggested including Moire-inducing line structures,

10 variable-sized dot patterns, latent images, see-throughs, bar-

11 codes, and diffraction based holograms. However, none of these

12 methods employs a true scrambled image or the added security

13 benefits deriving therefrom.

14   The inventor of the technology disclosed in this patent

15 previously invented a system for coding and decoding indicia

16 placed on printed matter by producing a parallax panoramagram

17 image. These principles and embodiments of U.S. Patent No.

18 3,937,565, issued February 10, 1976 and are hereby incorporated

19 by reference. The indicia were preferably produced

20 photographically using a lenticular plastic screen (i.e. a

21 lenticular screen) with a known spatial lens density (e.g. 69

22 lines per inch). A specialized auto-stereoscopic camera might

1   be used to produce the parallax image such as the one described

2   in this inventor's U.S. Patent No. 3,524,395, issued August 18,

3   1970, and U.S. Patent No. 3,769,890, issued November 6, 1973.

4   Photographic, or analog, production of coded indicia

5   images has the drawback of requiring a specialized camera.

6   Also, the analog images are limited in their versatility in

7   that an area of scrambled indicia is generally noticeable when

8   surrounded by non-scrambled images. Also, it is difficult to

9   combine several latent images, with potentially different

10   scrambling parameters, due to the inability to effectively re-

11   expose film segments in generating the scrambled, photographic

12   image.   Furthermore, it is difficult to produce secure

13   documents, such as currency, traveler's checks, stock and bond

14   certificates, bank notes, food stamps and the like which are

15   formed from a durable material resistant to tearing, staining,

16   fraying, and deterioration from day-to-day contact.

17   Accordingly, a method and apparatus are needed whereby the

18   photographic process and its results are essentially simulated

19   digitally via a computer system and related software.

20   Additionally, a system is needed whereby scrambled latent

21   images can be integrated into a source image, or individual

22   color components thereof, so that the source image is visible

23   to the unaided eye and the latent image is visible only upon

24   decoding. Also needed is the ability to incorporate multiple

3

1 latent images, representing different "phases", into the source

2 image for added security. Furthermore, what is needed is the

3 ability to apply this technology to a durable substrate, such

4 as a synthetic paper, and to incorporate an appropriate

5 verification lens integral within the document's structure.

6

7 **PRIOR ART:**

8 United States Patent 5,811,493 teaches extrudable

9 compositions comprising a thermoplastic polyester continuous

10 phase, a thermoplastic polyolefin discrete phase, and a

11 polyester-polyether, diblock, compatibilizer. Voided films

12 made from the composition are also disclosed, having a

13 paper-like texture and appearance.

14 United States Patent 4,010,289 teaches a method of

15 preparing synthetic resin film having high writability and

16 printability which comprises the steps of (I) carrying out

17 reaction by either of the following two processes: The process

18 A of reacting together 1. alicyclic polybasic acid or

19 anhydrides thereof, (2) polyepoxides containing at least two

20 epoxy groups and (3) a compound selected from the group

21 consisting of (a) unsaturated monobasic acid, (b) glycidyl

22 compounds containing a radical polymerizable unsaturated bond

23 and (c) unsaturated polybasic acid. The process B of reacting

24 together 1. at least one compound selected from the group

4

1 consisting of (a) polyepoxides containing at least two epoxy

2 groups and (b) alicyclic polybasic acid or anhydrides thereof

3 and (2) compounds containing vinyl and hydroxyl groups in the

4 molecule; (II) mixing the unsaturated polyester compounds

5 obtained in above process with fillers; (III) coating the

6 mixture on the surface of synthetic resin film; and (IV)

7 subjecting said coating to photopolymerization by irradiating

8 ultraviolet rays.

9   United States Patent 5,249,546 teaches the fabrication of

10 a printer's convenience item which may be added to a volume

11 such as a book, magazine, folder containing a stack of papers

12 or the like. The convenience item provides a bookmark which

13 projects away from a side page in the volume so that it may

14 fold over edges of the pages to act as a bookmark. In some

15 embodiments the base of the bookmark is wide enough to function

16 as a thumb tab. Preferably, the book mark is made of a durable

17 material such as a heavy duty paper or a plastic paper

18 substitute.

19   United States Patent 5,393,099 teaches a method of

20 producing an anti-counterfeiting document or currency which

21 acts and feels like existing paper currencies. The method

22 laminates two sheets of currency paper on each side of a thin

23 durable substrate film, thereby forming a durable document

24 which maintains a paper-like feel. The currency exhibits unique

1 and powerful anti-counterfeiting features.   The currency also

2 lasts significantly longer than conventional "paper" money.

3 None of the cited prior art references teach a secure

4 document, for example paper money, which has been modified to

5 contain both a particular scrambled indicia as a means of

6 hidden authentication and an integral means for verifying the

7 presence of said hidden indicia.

8

9 **SUMMARY OF THE INVENTION**

10 The present invention provides a durable and self-

11 verifying secure document system and a method for its

12 production.   The secure document system is potentially useful

13 for a wide variety of documents including, but not limited to,

14 lottery tickets, especially probability game lottery tickets,

15 currency, traveler's checks, passports, stock and bond

16 certificates, bank notes, driver's licenses, wills, coupons,

17 rebates, contracts, food stamps, magnetic stripes, test answer

18 forms, invoices, tickets, inventory forms, tags, labels and

19 original artwork.

20 Comparison of paper in general use prepared from pulp with

21 recently developed synthetic resin film shows that pulp paper

22 generally has lower tensile strength, dimensional stability and

23 resistance to moisture, water corrosion and folding, than the

24 latter.   Synthetic resin films having high writability and

1 printability have been marketed which eliminate the

2 above-mentioned drawbacks of pulp paper. These synthetic resin

3 films are often treated to enhance printability. These

4 treatments include physical treatment processes such as those

5 which sandblast, emboss and mat the surface of synthetic resin

6 film, apply corona discharges to said surface or subject said

7 film to high temperature treatment; ozone treatment processes,

8 chemical treatment processes such as those which treat the

9 surface of synthetic resin film with chemicals, for example,

10 chlorine, peroxides, and mixed solutions of potassium chromate

11 and concentrated sulfuric acid; and processes which coat said

12 surface with high polymer compounds having a polar group such

13 as polyvinyl alcohol, and carry out the graft polymerization of

14 monomers having a polar group.

15   The instant invention is particularly durable when

16 produced on one of the modern plastic paper substitutes. In one

17 embodiment, a synthetic printing sheet sold under the trademark

18 TESLIN by PPG Industries, Inc., may be utilized. The TESLIN

19 material has the qualities of paper and is tough enough to

20 survive very rough usage, such as that to which circulating

21 currency is exposed. The base material is in the polyolefin

22 family and can be adapted to a wide range of printing and

23 fabricating techniques. It accepts a broad variety of inks and

1   can be printed with offset, inkjet, screen, laser, and thermal

2   transfer processes.

3   Another such material from which the secure documents of

4   the instant invention could be manufactured is KIMDURA a

5   synthetic paper, made by Kimberly-Clark Corporation, which is

6   one of a variety of latex saturated durable papers produced by

7   that corporation. These materials exhibit benefits in several

8   critical areas including cost reduction. KIMDURA is a

9   polypropylene film which is not only completely recyclable, but

10 is so durable that it can be used for a long period of time.

11 Other similar materials are sold under the trademarks PREVAIL,

12 BUCKSIN, TEXOPRINT, TEXOPRINT II and DURAWEB, all of which are

13 manufactured by the Kimberly-Clark Corporation. These materials

14 represent durable paper substitutes which have been designed

15 for unique applications involving toughness and aesthetic

16 excellence. They retain the look, touch and feel of long

17 lasting durable papers.

18   Still other materials which could be utilized include

19 those sold under the trademarks ASCOT and TYVEK, both of which

20 are products of DuPont Corp; the material sold under the

21 trademark ASCOT is made from 100% polyolefin filaments randomly

22 dispersed and bonded to provide paper-like properties. To this

23 base sheet, a specially formulated coating is applied to assure

24 high fidelity printing and to protect the filaments from the

1   degrading effect of prolonged exposure to light. ASCOT requires

2   the use of specially formulated ink containing no more than 3%

3   volatile material to prevent swelling and distortion of the

4   paper substitute material. High tack and viscosity inks are

5   recommended to obtain even ink lay in solids and even tone in

6   screen areas. ASCOT'S unusual features of strength, tear

7   resistance, fold resistance, durability, water and light

8   resistance and no grain direction, combined with its low weight

9   to bulk ratio, make it well-suited for secure document

10   applications.

11   Cellulose tear-resistant materials include the

12   MASTER-FLEX brand of latex impregnated enamels providing high

13   quality sheets are manufactured by Appleton. The material is a

14   latex impregnated enamel providing a high quality sheet of

15   paper substitute material which is formed on a fourdrinier

16   machine with a unique makeup that enables the sheet to accept

17   saturation process. After saturation, the web of Master-Flex

18   material passes through squeeze rolls to remove excess

19   saturants. Then, it is cured and dried. Double coaters apply

20   the highly specialized coating, composed of clays, brighteners

21   and adhesives, for producing a pinhole-free sheet.

22   Supercalendered to a smooth, level surface with medium gloss

23   finish, the MASTER-FLEX material is designed primarily for

24   offset printing, offering good ink holdout. Quick-set inks are

1   recommended for both offset and letterpress production. The

2   surface accepts varnishes, lacquers and adhesives and

3   converting operations, such as sewing, diecutting and

4   perforating. A sheet of this material can be folded and

5   refolded without cracking or flaking.

6   Other plastic paper substitutes or sturdy papers, paper

7   boards, reinforced papers and reinforced paper substitutes,

8   along with laminate composites including combinations of paper

9   and non-paper materials are contemplated as suitable substrates

10   for the secure documents disclosed herein. For convenience of

11   expression all of these similar substrates will be identified

12   as "plastic paper substitutes" in this specification and in the

13   claims.

14   The authenticating scrambled indicia is associated with the

15   plastic paper substitute's surface by a software method and

16   apparatus for digitally scrambling and incorporating latent

17   images into a source image. The latent image -- in digitized

18   form -- can be scrambled for decoding by a variety of

19   lenticular lenses as selected by the user, with each lens

20   having different optical properties such as different line

21   densities per inch, and/or a different radius of curvature for

22   the lenticulars. Different degrees of scrambling might also be

23   selected wherein the latent image is divided up into a higher

24   multiplicity of lines or elements. For decoding purposes, the

1 multiplicity of elements would be a function of the lens

2 density.

3 The source image is then rasterized, or divided up into a

4 series of lines equal in number to the lines making up the

5 scrambled latent images. Generally, when hard copy images are

6 printed, the image is made up of a series of "printers dots"

7 which vary in density according to the colors found in the

8 various component parts of the image. The software method and

9 apparatus of the present invention, takes the rasterized lines

10 of the source image and reforms them into the same general

11 pattern as the lines of the scrambled latent image. Hence,

12 where the source image is darker, the scrambled lines are

13 formed proportionately thicker; where the source image is

14 lighter, the scrambled lines are formed proportionately

15 thinner. The resulting combined image appears to the unaided

16 eye like the original source image. However, since the

17 component rasterized lines are formed in the coded pattern of

18 the scrambled latent image, a decoder will reveal the

19 underlying latent image. Due to the high printing resolution

20 needed for such complex scrambled lines, attempts to copy the

21 printed image by electromechanical means, or otherwise, are

22 most often unsuccessful in reproducing the underlying latent

23 image.

24

1   As a result of this digital approach, several different

2   latent images can be scrambled and combined into an overall

3   latent image, which can then be reformed into the rasterized

4   source image. This is achieved by dividing the rasterized

5   lines into the appropriate number of images (or phases) and

6   interlacing the phased images in each raster line element.

7   Each individual latent image might be oriented at any angle and

8   scrambled to a different degree, so long as the scrambling of

9   each image is a functional multiple of the known decoder

10   frequency. Alternatively, the grey scale source image might be

11   divided up into primary component printing colors (e.g. cyan,

12   magenta, yellow, and black, or CMYK; red, green, blue, or

13   RGB). Single color bitmap formats might also be used for

14   certain applications. A scrambled latent image, or a multi-

15   phased image, could then be individually reformed into each

16   component color. Upon rejoining of the colors to form the

17   final source image, the decoder will reveal the different

18   latent images hidden in the different color segments.

19   The present invention also allows the option of flipping

20   each of the elements of the latent image after it has been

21   divided or scrambled into its elemental line parts. As has

22   been discovered by the inventor, this unique step produces

23   relatively sharper decoded images when each of the elements is

24   flipped about its axis by one-hundred and eighty (180) degrees.

1 This same effect was achieved by the process of U.S. Patent No.

2 3,937,565, and the cited stereographic cameras therein, through

3 the inherent flipping of an object when viewed past the focal

4 point of a lens. The flipped elemental lines are then reformed

5 into the rasterized source image. While enhancing the

6 sharpness of the latent image, the flipping of the elements has

7 no adverse, or even noticeable, effect on the appearance of the

8 final coded source image. Moreover, by combining two images

9 consisting of one image where the elements are flipped and

10 another where they are not flipped, the appearance of a spatial

11 separation of the two images will occur upon decoding.

12   As needed, the source image might simply consist of a

13 solid color tint or a textured background which would contain

14 hidden latent images when viewed through the proper decoder.

15 Such solid, tinted areas might frequently be found on checks,

16 currency, tickets, etc.

17   Other useful applications might include the latent

18 encoding of a person's signature inside a source image

19 consisting of that person's photograph. Such a technique would

20 make it virtually impossible to produce fake ID's or driver's

21 licenses through the common technique of replacing an existing

22 picture with a false one. Other vital information besides the

23 person's signature (e.g. height, weight, identification number,

1 etc.) might also be included in the latent image for encoding

2 into the source image.

3 Still other useful applications might include, for

4 example, the following: passports, currency, special event

5 tickets, stocks and bond certificates, bank and travelers

6 checks, anti-counterfeiting labels (e.g. for designer clothes,

7 drugs, liquors, video tapes, audio CD's, cosmetics, machine

8 parts, and pharmaceuticals), birth certificates, land deed

9 titles, and visas.

10 It is an object of the instant invention to produce a

11 security document or currency which acts and feels like

12 existing paper currency, and exhibits unique and powerful

13 anti-counterfeiting features including the incorporation of

14 scrambled indicia authentication and integral verification.

15 It is a further the object of the present invention to

16 create a document/currency substrate that will increase the

17 average lifespan of the currency in circulation thereby

18 reducing overall document/currency costs.

19 An additional objective of the present invention is to

20 provide a counterfeit-deterrent method and apparatus, as

21 implemented by a software program on a computer system, for

22 producing scrambled or coded indicia images, typically in a

23 printed form. The coded image can then be decoded and viewed

1 through a special lens which is matched to the software coding

2 process parameters.

3   A further objective of the present invention is to provide

4 a counterfeit-deterrent method and apparatus, as implemented by

5 a software program on a computer system, wherein a source image

6 is rasterized, and the latent image is broken up into

7 corresponding elemental lines, and the rasterized source image

8 is reconstructed according to the coded pattern of the

9 scrambled image.

10   Yet a further objective of the present invention is to

11 provide a counterfeit-deterrent method and apparatus, as

12 implemented by a software program on a computer system, wherein

13 the source image is converted into a grey scale image for

14 incorporation of a latent scrambled image.

15   Still another objective of the present invention is to

16 provide a counterfeit-deterrent method and apparatus, as

17 implemented by a software program on a computer system, wherein

18 the grey scale source image is further separated out into its

19 component color parts for possible incorporation of latent

20 scrambled images into each component color part, with the parts

21 being rejoined to form the final encoded source image.

22   A related objective of the present invention is to provide

23 a counterfeit-deterrent method and apparatus, as implemented by

24 a software program on a computer system, wherein the elemental

15

1   lines of the scrambled image may be rotated or flipped about

2   their axis as necessary, or as selected by the user.

3   A further objective of the present invention is to provide

4   a counterfeit-deterrent method and apparatus, as implemented by

5   a software program on a computer system, wherein the "single

6   phased" the scrambled image consists of a first latent image

7   which has been sliced and scrambled as a function of a user

8   selected decoder density and scrambling factor.

9   Yet another objective of the present invention is to

10 provide a counterfeit-deterrent method and apparatus, as

11 implemented by a software program on a computer system, wherein

12 the "two phased" scrambled image is sliced as a function of a

13 user selected decoder density, and each slice is halved into

14 two sub-slices, and the first and second latent images are

15 alternately interlaced in the sub-slices, with each latent

16 image scrambled by a user selected scrambling factor.

17   Still another objective of the present invention is to

18 provide a counterfeit-deterrent method and apparatus, as

19 implemented by a software program on a computer system, wherein

20 the "three phased" scrambled image is sliced as a function of

21 a user selected decoder density, and each slice is divided into

22 three sub-slices, and the first, second, and third latent

23 images are alternately interlaced in the sub-slices, with each

24 latent image scrambled by a user selected scrambling factor.

1 Yet another objective of the present invention is to

2 provide a counterfeit-deterrent method and apparatus, as

3 implemented by a software program on a computer system, wherein

4 an "indicia tint" is produced which is similar to a two phased

5 SI, but with one source file, and every second sub-slice of the

6 input image is the complimenter of the first sub-slice.

7 A further objective of the present invention is to provide

8 a counterfeit-deterrent method and apparatus, as implemented by

9 a software program on a computer system, wherein the source

10 image consists of a solid color or tint pattern with the

11 scrambled image incorporated therein, but the elemental lines

12 are flipped only where a letter or object occurs in underlying

13 latent image.

14 Still another objective of the present invention is to

15 provide a counterfeit-deterrent method and apparatus, as

16 implemented by a software program on a computer system, wherein

17 the latent image is encoded directly into a certain visible

18 figure on the source image, thus creating a "hidden image"

19 effect.

20 Yet another objective of the present invention is to

21 provide a counterfeit-deterrent method and apparatus, as

22 implemented by a software program on a computer system, wherein

23 a bitmap source image is used (instead of a grey scale image)

17

1 to create hidden images behind single color source images or

2 sections of source images.

3 Still another related objective of the present invention

4 is to provide a counterfeit-deterrent method and apparatus, as

5 implemented by a software program on a computer system, wherein

6 a multilevel, 3-dimensional relief effect is created by

7 applying different scrambling parameters to an image and its

8 background.

9 Another related objective of the present invention is to

10 provide a counterfeit-deterrent method and apparatus, as

11 implemented by a software program on a computer system, wherein

12 "void tint" sections might be produced and the word "void," or

13 similar such words, would appear across documents if attempts

14 are made to photocopy them.

15 Yet another possible objective of the present invention is

16 to use the software program and computer system to produce the

17 equivalent of "water marks" on paper products.

18 Still another possible objective of the present invention

19 is to use the software program and computer system to produce,

20 or to aid in producing, holographic images through line

21 diffraction techniques.

22 Other objectives and advantages of this invention will

23 become apparent from the following description taken in

24 conjunction with the accompanying drawings wherein are set

18

1   forth, by way of illustration and example, certain embodiments

2   of this invention. The drawings constitute a part of this

3   specification and include exemplary embodiments of the present

4   invention and illustrate various objects and features thereof.

5

6   **BRIEF DESCRIPTION OF THE DRAWINGS**

7   Figure 1 shows a "one phase" example of the Scrambled

8   Indicia (SI) process wherein an output image is sliced into

9   elements as a function of the frequency of the decoding lens

10   and the scrambling factor (or zoom factor, or base code) as

11   selected by the user.

12   Figure 2(a) shows a scrambled "P" (above) with its

13   resulting elements enlarged 400% (below) wherein the elements

14   have been flipped 180 degrees about their vertical axes.

15   Figure 2(b) shows the scrambled "P" (above) of Figure 9(a)

16   with its resulting elements enlarged 400% (below) wherein the

17   elements have not been flipped or altered.

18   Figure 3 shows a "two phase" SI example of slicing the

19   output image, wherein the width of the slice is one half of the

20   one phase example, with every odd slice being from a 'source

21   one' file, and every even slice being from a 'source two' file.

22   Figure 4 shows a "three phase" SI example of slicing the

23   output image, wherein the width of the slice is one third of

19

1   the one phase example, with every third slice being from the

2   same source input file.

3   Figure 5 shows a comparison of the one, two, and three

4   phase scrambled and coded results.

5   Figure 6 shows a series comparison of scrambled images as

6   a function of increasing lens frequency (or line density per

7   inch) from 10 through 100.

8   Figure 7 shows a series comparison of scrambled images as

9   a function of increasing zoom factor (or base code) ranging

10   from 30 through 250, for a given lens frequency.

11   Figure 8 shows a series comparison of two phased scrambled

12   images wherein the first latent image and the second latent

13   image are rotated with respect to each other ranging from 10

14   through 90 degrees.

15   Figure 9 shows the steps involved to encode, as hidden

16   images, two separate scrambled indicia patterns into two

17   separate base colors as extracted from the original source

18   image.

19   Figure 10 shows an example hardware configuration for

20   running the S.I. software and performing the SI process.

21   Figure 11 shows examples of rastering techniques with the

22   accompanying circles indicating an enlarged view of a portion

23   of the overall pattern.

24

1   Figure 12 is a pictorial view of a currency document

2 containing integral verification means;

3   Figure 13 is a rear view of Figure 12;

4   Figure 14 illustrates Figure 12 in a folded configuration

5 to position the verification means juxtaposed the

6 authenticating indicia;

7   Figure 15 is a pictorial view of a passport having a

8 picture with hidden indicia and an optical viewing lens sized

9 to follow the shape of the passport;

10   Figure 16 is Figure 15 with the optical viewing lens

11 placed over the picture;

12   Figure 17 is a pictorial view of a passport having a

13 picture with indicia and optical viewing lens forming a window.

14   Figure 18 is Figure 17 with said optical viewing lens

15 window placed over the picture.

16

17 **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

18   Although the invention will be described in terms a

19 specific embodiment with certain alternatives, it will be

20 readily apparent to those skilled in this art that various

21 modifications, rearrangements and substitutions can be made

22 without departing from the spirit of the invention. The scope

23 of the invention is defined by the claims appended hereto.

24   Scrambled Indicia (SI) is a registered trademark of

1   Graphic Securities Systems Corporation and draws attention to

2   a proprietary process which includes a process of rasterizing,

3   or dividing up into lines, a source or visible image according

4   to the frequency (or density) of a lenticular decoder lens.

5   The number of lines is also a function of the scrambling

6   factor, or zoom factor, as applied to a latent or secondary

7   image. After the latent image is processed and scrambled, a

8   set of scrambled or hidden lines exists which can then be

9   combined into the rasterized lines of the visible image. The

10   visible image is thus reformed, or re-rasterized, according to

11   the pattern of the hidden latent image lines. Where the

12   visible image is darker, the scrambled or hidden lines are made

13   proportionately thicker in re-forming the rasterized lines of

14   the visible image; similarly, where the visible image is

15   lighter, the scrambled lines are made proportionately thinner.

16   As a result, a new visible image is created, but with the

17   encoded, latent, SI pattern being visible "underneath" when

18   viewed through a transparent decoder lens.

19   Referring now to Figure 1, certain example details of the

20   process are shown. In this example, one latent image is

21   processed into a visible source image, and this process is

22   generally referred to as a "one phase" SI operation. In any SI

23   operation, an output image is a function of the decoder lens

24   density. An output image 2 is shown which is sliced up into

1 elemental slices, or segments, of width h. (See reference 4).

2 Each slice width h is a function of several factors such as

3 density and base code.

4 As for lens density, the inventor has assigned reference

5 names to lenses with various frequencies (or line densities per

6 inch), including for instance, the following: D-7X with 177

7 lines/inch; D-7 with 152.5 lines/inch; D-6 with 134 lines/inch;

8 D-9 with 69 lines/inch. (See reference 6). The software for

9 performing this process also provides an "x2" (or doubling

10 factor, df) option which doubles the effective line density,

11 and hence divides the output image up into twice as many

12 slices. The resulting SI image will still be decodable by the

13 selected lens because the number of lines is an even multiple

14 of the frequency of the lens.

15 The output image slice, having width h, is processed as a

16 function of the input slice width I (see reference 8). In

17 turn, width I is a function of width h, the lens density, and

18 a base code factor (or scrambling factor) as selected by the

19 user.

20

21 These formulas are as follows:

22   df = 2 (if "x2" selected); 1 (by default)
23   o = h*density/100   (See reference 10)
24   I = o*base code(B)   (See reference 8)
25
26
27

1   Rearranging these formulas, the value for h becomes:
2
3   (1/B)*100
4   h = ------------
5   Density*df
6
7   Hence, as the value for the base code and/or the density is

8   increased, the width h will decrease. A larger base code, or

9   scrambling factor, therefore creates more lines and results in

10 a more distorted or scrambled image.

11   Additionally, the SI process allows the option of flipping

12 12 the input slice to affect the sharpness of the image.

13 Referring now to Figure 2(a), the letter "P" is shown scrambled

14 30 according to the S.I. process. An image 34 enlarge by 400%

15 further shows the characteristic elements 38. In this instance

16 the elements have each been individually flipped 180 degrees

17 about their vertical axis. Figure 2(b) shows the same example

18 "P" 32, and enlarged version 36 where the elements have not

19 been flipped. When viewed through the proper decoder lens for

20 these particular S.I. parameters, the flipped "P" will appear

21 sharper, or more visually distinct, than the unflipped "P".

22 For any scrambled image, the software provides the user the

23 option of flipping or not flipping the elements, as further

24 detailed below.

25   Referring now to Figure 3, a "two phase" SI process is

26 shown whereby the method is similar to that for the one phase

27 SI. In this case, however, each slice of width h is further

1   divided into a first and second sub-slice. The elemental lines

2   of first and second scrambled images will be stored by the

3   software program in 'source one' and 'source two' files. In

4   the resulting output image, the odd slices 14 are composed of

5   elemental lines from the source one file, and the even slices

6   16 are from the source two file. Upon decoding, the first and

7   second scrambled images will appear independently discernable.

8   Referring now to Figure 4, a "three phase" SI process is

9   shown as similar to the one and two phase SI processes. In

10   this case, width h is divided into three parts. The first,

11   second, and third scrambled images are stored in three computer

12   source files. In the resulting output image, every third slice

13   18, 20, and 22 comes from the same respective first, second, or

14   third source file. Again upon decoding, the first, second, and

15   third scrambled images will appear independently discernable.

16   Referring to Figure 5, a comparison is shown of the one,

17. two, and three phase scrambled results for a given lens density

18   and base code. Figure 6 shows a comparison of the scrambled

19   results for a given base code and a varying set of lens

20   densities ranging from 10 through 100 lines per inch. As the

21   lens density increases, the relatively width of each elemental

22   line decreases and causes the scrambled image to be harder to

23   discern. In Figure 7, the lens density is fixed while the zoom

24   factor, or base code, is increased through a series of values

25

1   ranging from 30 - 250. Similarly as per the formulas above, as

2   the base code is increased, the relative width of each

3   elemental line decreases and causes the scrambled image to be

4   harder to discern.   As shown, the discernability of the

5   scrambled image for a zoom factor of 30 is far greater than for

6   a zoom factor of 250.

7   Another benefit or feature of multiple phasing is that

8   each latent image can be oriented at a different angle for

9   added security.   Referring now to Figure 8, a series of two

10 phase images is shown where the first latent image remains

11 fixed and the second latent image is rotated, relative to the

12 first image, through a series of angles ranging from 10 - 90

13 degrees.

14   Referring now to Figure 9, an example of the versatility

15 offered by a software version of the S.I. process is shown. In

16 this example, a postage stamp is created whereby the S.I.

17 process incorporates two different latent images, oriented 90

18 degrees to each other, into two different base colors of the

19 visible source image. The visible source image -- as comprised

20 of its original RGB colors -- is scanned, as a digital high

21 resolution image, into a program such as ADOBE PHOTOSHOP. The

22 image is then divided into its component color "plates" in yet

23 another commonly used color format CMYK, wherein the component

24 images of Cyan 42, Magenta 44, Yellow 46, and Black 48 are

1   shown. The versatility of the S.I. software allows for the

2   easy combination of a latent S.I. image with any one component

3   color of the visible image. In this case, the latent invisible

4   image 50 with the repeated symbol USPS is scrambled and merged

5   with the Cyan color plate 42. The resulting Cyan color plate

6   52 -- as described above -- will show the original visible

7   image in a rasterized pattern to the unaided eye, but the

8   latent invisible image will be encoded into the rasterized

9   pattern. A second latent invisible image 54 with the repeated

10   trademark SCRAMBLED INDICIA (of this inventor) is merged with

11   the Magenta color plate 44 to produce the encoded Magenta image

12   56. The final visible image (similar to 40) will then be re-

13   composed using the original Yellow and Black plates along with

14   the encoded Cyan and Magenta plates.

15   The self authenticating document may include hidden indica

16   customized to a particular need, including the currency of a

17   country. In operation, a source image is first digitized and

18   then divided out into its component CMYK colors. Each color

19   plate can be independently operated on and typically includes

20   a hidden image technique (or rasterization in single color).

21   The target color plates are rasterized and the scrambling

22   process applied to the latent images. The first latent image is

23   merged with the rasterized Cyan color plate, the second image

24   is merged with the rasterized Magenta color plate. The final

27

1 output image is a created by re-joining the encoded Cyan and

2 Magenta color plates with the unaltered Yellow and Black color

3 plates. In this example, only the Cyan and Magenta colors were

4 encoded. Other examples might choose to encode one color,

5 three colors, or all four colors.

6   A useful application for the S.I. Rastering technique is

7 where the visible image is a photograph and the latent image

8 might be a signature of that person. Using the SIS program,

9 the visible image can be rasterized and then the signature

10 image can be scrambled and merged into the visible image raster

11 pattern. The resulting encoded image will be a visible image

12 of a person's photograph, which when decoded will reveal that

13 person's signature. The latent image might include other vital

14 statistics such as height, weight, etc. This high security

15 encoded image would prove to be extremely useful on such items

16 as passports, licenses, photo ID's, etc.

17   The processes described above have used line rastering

18 techniques as derived from the suggested lenticular structure

19 of the decoding lens. Other rastering techniques might also be

20 used, which would be accompanied by corresponding decoder

21 lenses capable of decoding such rastered and scrambled

22 patterns.

23

1   While this process might be implemented on any computer

2   system, the preferred embodiment uses a setup as shown in

3   Figure 10. Various image files, as stored in "tif" format 60,

4   are fed into a SILICON GRAPHICS INC. (SGI) workstation 62 which

5   runs the software. While the software might run on any

6   computer capable of handling high resolution graphics, the SGI

7   machine is used because of its superior speed and graphical

8   abilities. The files are opened by the S.I. software and the

9   scrambled indicia types, values, and parameters are set by the

10 program user 64. Encoding algorithms are applied by the

11 software to merge latent images with visible images to create

12 a new scrambled "tif" file 66. The new "tif" file is then fed

13 into a MACINTOSH computer 68 for implementation into the final

14 design program, wherein the file is converted into an

15 Encapsulated PostScript (EPS) file format 70. The finished

16 design is then sent to an output device of choice 72 which is

17 capable of printing the final image with the resolution

18 necessary to maintain and reveal the hidden latent images upon

19 decoding. The preferred output device is manufactured by

20 SCITEX DOLVE

21   Referring now to Figure 11, a series of example rastering

22 techniques are shown which could similarly be used to encode

23 scrambled images into rasterized visible source images.

24 Accompanying each type of rastering is a circle showing an

29

1 enlarged portion of the raster. The example types include:

2 double line thickness modulation; line thickness modulation II;

3 emboss line rastering; relief; double relief; emboss round

4 raster; cross raster; latent round raster; oval raster; and

5 cross line raster. Another technique, cross embossed

6 rastering, might use one frequency of lens density on the

7 vertical plane and yet another frequency on the horizontal

8 plane. The user would then check each latent image by rotating

9 the lens. Yet another technique would include lenses which

10 varying in frequency and/or refractive characteristics across

11 the face of a single lens. Hence different parts of the

12 printed matter could be encoded at different frequencies and

13 still be decoded by a single lens for convenience. Undoubtedly

14 many other rastering types exist which are easily adaptable to

15 the SIS encoding techniques.

16   Regardless of the type of rastering used, a variety of

17 other security measures could be performed using the SIS

18 program and the underlying principles involved. For instance,

19 the consecutive numbering system found on tickets or money

20 might be scrambled to insure further security against copying.

21 The SIS program might also digitally generate scrambled bar

22 encoding.   A Method and Apparatus For Scrambling and

23 Unscrambling Bar Code Symbols has been earlier described in

24

1   this inventors U.S. Patent 4,914,700, the principles of which

2   are hereby incorporated by reference.

3   Yet another common security printing technique includes

4   using complex printed lines, borders, guilloches, and/or

5   buttons which are difficult to forge or electronically

6   reproduce. The SIS program can introduce scrambled patterns

7   which follow certain lines on the printed matter, hence the

8   inventor refers to this technique as Scrambled Micro Lines.

9   The security of the Scrambled Indicia might be further

10   enhanced by making 3 color separations in Cyan, Magenta, and

11   Yellow of the image after the S.I. process has been performed.

12   These colors would then be adjusted to each other so that a

13   natural grey could be obtained on the printed sheet when the

14   colors are recombined. The inventor refers to this process as

15   "grey match." Hence, while the printed image would appear grey

16   to the unaided eye, the decoded image would appear in color.

17   The adjustment of the separations to maintain a neutral grey

18   becomes yet another factor to be controlled when using

19   different combinations of ink, paper, and press. Maintaining

20   these combinations adds another level of security to valuable

21   document and currency.

22   Still another possible use of the SIS program would be to

23   create interference, or void tint, combinations on printed

24   matter. This technique will conceal certain words, like "void"

31

1 or "invalid" on items such as concert tickets. If the ticket

2 is photocopied, the underlying word "void" will appear on the

3 copy and hence render it invalid to a ticket inspector. The

4 SIS software would provide an efficient and low cost

5 alternative to producing such void tint patterns.

6 The SIS program might also be adapted to produce

7 watermark-type patterns which are typically introduced to paper

8 via penetrating oil or varnish. Furthermore, the SIS program

9 might be applicable to producing holograms via line diffraction

10 methods. Again, the SIS program would prove to be more

11 efficient and cost effective for producing such results.

12 Referring to Figure 12, an example of a self-verifying

13 secure document is illustrated. The secure document system is

14 potentially useful for a wide variety of documents including,

15 but not limited to, lottery tickets, currency, traveler's

16 checks, passports, stock and bond certificates, bank notes,

17 driver's licenses, wills, coupons, rebates, contracts, food

18 stamps, magnetic stripes, test answer forms, invoices, tickets,

19 inventory forms, tags, labels and original artwork.   The

20 currency depicted 100 consists of a plastic paper substitute

21 102 having various indicia 104 associated therewith including

22 visible and hidden indicia. Application of the hidden indicia

23 to the plastic paper substitute is implemented in accordance

24 with the above captioned computer software program should

1   customized indicia be employed or, in the example of currency,

2   be typeset for large scale production, The document includes an

3   integral lens area 106 which is particularly designed to verify

4   the document's authenticity by rendering the hidden indicia

5   visible to the viewer. The instant invention is particularly

6   durable when produced on one of the modern plastic paper

7   substitutes. The self-authenticating article 100 is based upon

8   a plastic paper substitute adapted to retain various forms of

9   indicia 104 with a means particularly adapted for revealing

10   hidden indicia. The means defining an authenticating area

11   forms a unitary and integral structure in combination with said

12   plastic paper substitute. The authenticating area 106 is

13   positionable in juxtaposed relation to the hidden indicia 104

14   thereby providing instant verification of the authenticity of

15   the article. The self authenticating article may include the

16   hidden indicia in one or more digitally produced latent images,

17   each image being encoded in accordance with particular

18   parameters with revelation of the hidden indicia achievable

19   only by a particularly programmed authenticating lens.

20   The self authenticating article is formed from a plastic

21   paper substitute selected from the group consisting of

22   synthetic resin films having a high degree of writability and

23   printability,   laminate   composite   structures   including

33

1 combinations of paper and non-paper materials, latex saturated

2 durable papers, coated polyolefin substrates formed from

3 randomly dispersed and bonded polyolefin filaments, reinforced

4 papers, and combinations thereof. The self authenticating

5 article with the lens incorporated therein is especially suited

6 for currency, stock certificates, bond certificates, special

7 event tickets, tax stamps, official certificates, passports,

8 bank and travelers checks, anti-counterfeiting labels, birth

9 certificates, land deed titles, visas, food stamps, lottery

10 tickets, driver's licenses, holograms, insurance documents,

11 wills, coupons, rebates, contracts, test answer forms,

12 invoices, inventory forms, and original artwork in juxtaposed

13 relation to said hidden indicia thereby providing instant

14 verification of the authenticity of said article.

15 The authenticating means is a optical viewing lens, such

16 as a Fresnel lens, that can be inlaid, preformed, or produced

17 by an intaglio engraving process. The self authenticating

18 article may have one or more digitally produced latent images

19 encoded in accordance with particular parameters of the

20 decoder, whereby revelation of the hidden indicia is only

21 achievable by a decoder of a particularly frequency.

22

1   Figure 15 is a pictorial view of a passport 130 having a

2   picture 132 having hidden indicia placed therein.   In this

3   embodiment, the optical viewing lens 134 is sized to follow the

4   shape of the passport 130. The lens 134 is formed of the sheet

5   like material and is attached to the passport in a similar

6   manner as the remaining pages. As shown in Figure 16, the lens

7   134 is placed over the picture 132 for purposes of revealing

8   the hidden indica 136.

9   In yet another example of this use, Figure 17 depicts a

10   pictorial view of a passport 150 having a picture 152 having

11   hidden indicia placed therein. In this embodiment, the optical

12   viewing lens 154 is formed integral to a passport sheet 156.

13   As shown in Figure 16, when the sheet 156 is placed over the

14   picture 152, the lens 154 has been placed in an alignment

15   position for purposes of revealing the hidden indica 158.

16   It is to be understood that while I have illustrated and

17   described certain forms of my invention, it is not to be

18   limited to the specific forms or arrangement of parts herein

19   describe and shown. It will be apparent to those skilled in

20   the art that various changes may be made without departing from

21   the scope of the invention and the invention is not to be

22   considered limited to what is shown in the drawings and

23   described in the specification.

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